THz DETECTOR USING A PHOTOCONDUCTIVE ANTENNA AT HBESL

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Our goals

Main target:

- Using MenloSystems TERA8 antenna for time resolved THz radiation detection produced by an accelerated electron beam and propagating into materials to study.

Project specific goals:

- Study the performances of the device with a very low power THz source;
- Building an optical systems and its control software which can be also used for all the future experiments;
- Comparing the results with other THz detection systems;

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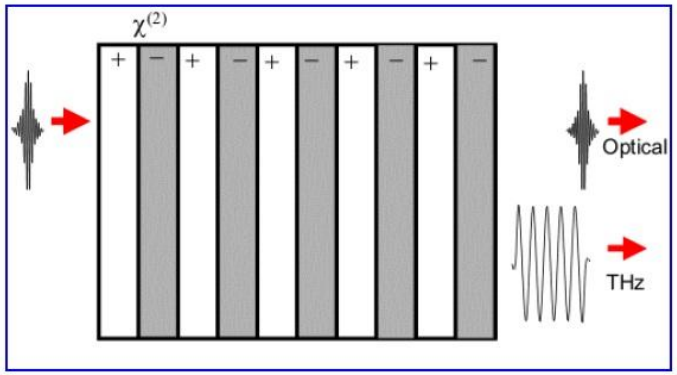
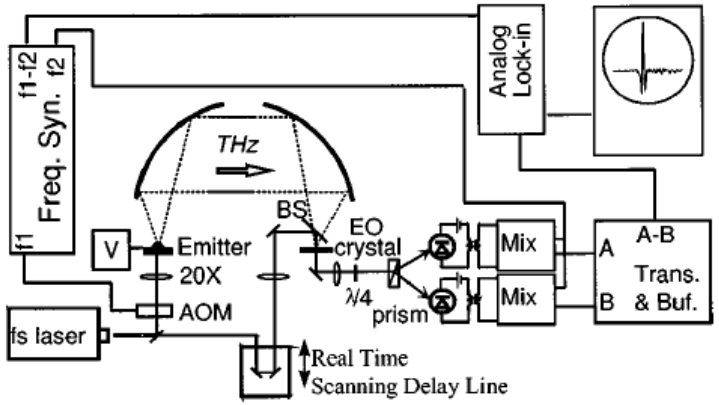
Electro-optic sampling





$$\eta_{THz} = \frac{2\omega^2 d_{eff}^2 L^2 I}{\varepsilon_0 n_v^2 n_{THz} c^3}$$

Performances:

- Electro optical rectification process: very low efficiency (around 10^{-6} in the best cases);
- Highest detection bandwidth among all systems (up to 20THz);
- SNR=40dB at 1μW of THz power.

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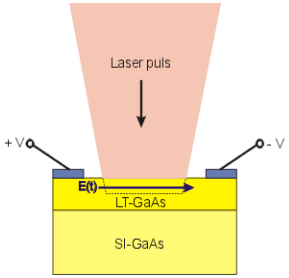
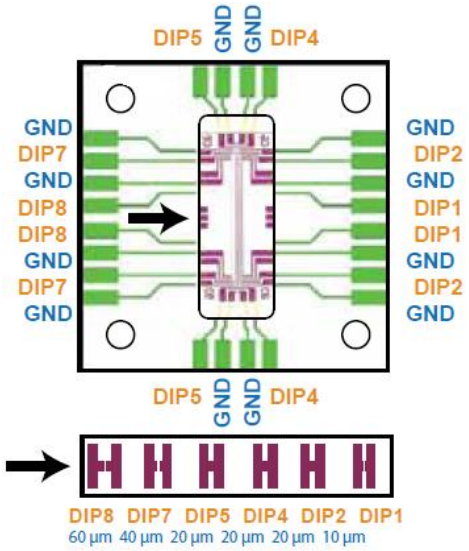
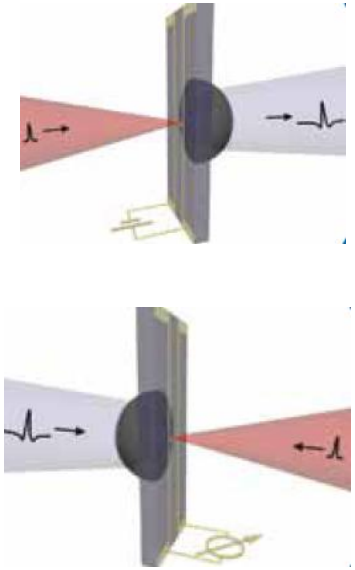
Photoconductive antenna







Performances:

- The bandwidth is limited at 3-4 THz depending on internal structure;
- The maximum THz power permitted is lower than a crystal;
- The measurement is direct;
- SNR=65dB at 1µW THz power.

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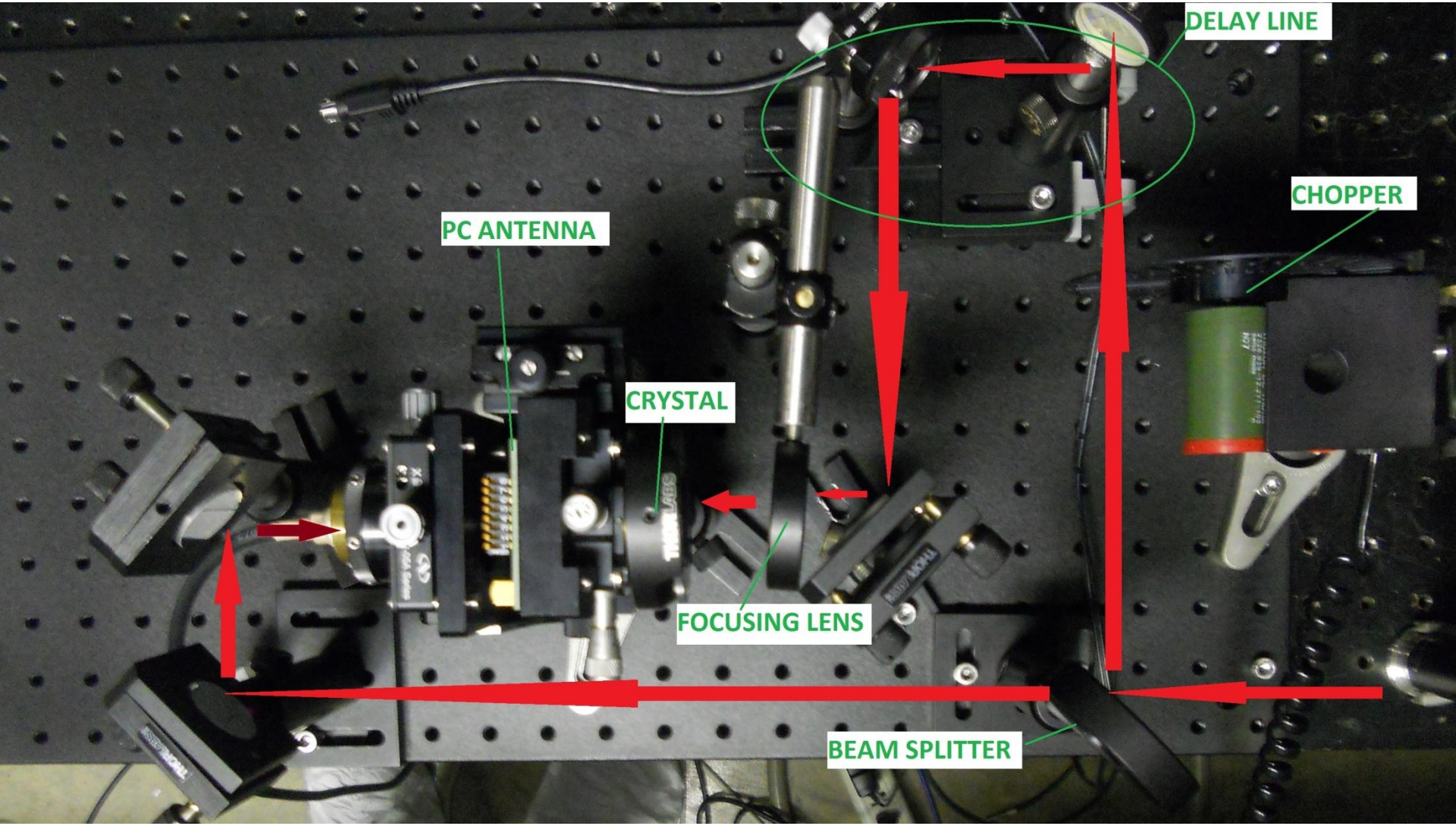
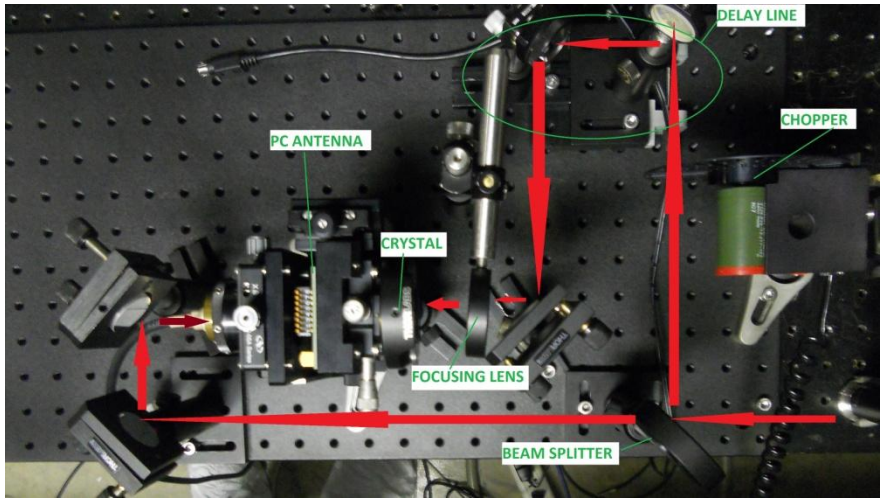

DELAY LINE
CHOPPER
PC ANTENNA
CRYSTAL
FOCUSING LENS
BEAM SPLITTER

Our system



- Octavius laser by Thorlabs: 37 fs RMS pulses at 81.25 MHz;
- Very broadband directly from the oscillator and not amplified;
- ZnTe crystal as an emitter with efficiency around 10^{-10} , total power to detect around 1pW;
- 5.6 cm delay line, 58 cm total path;
- Use of low-noise current to voltage amplifier and lock-in detection;

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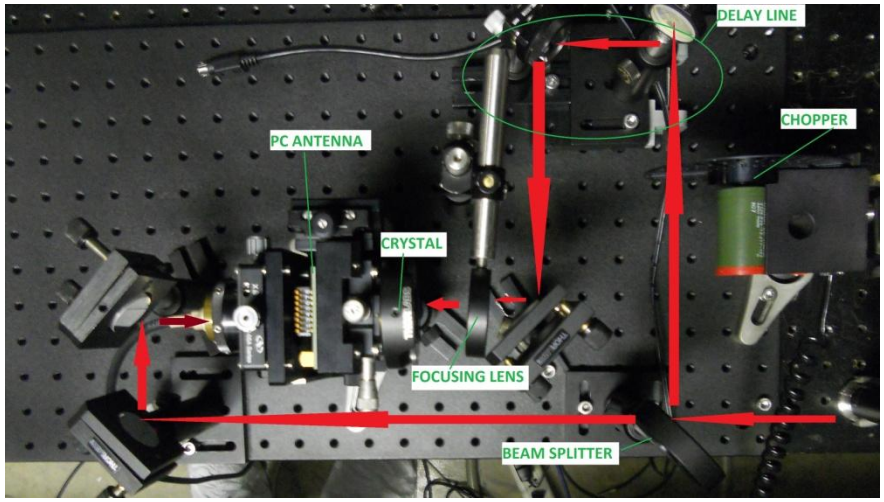
Our system



- A precise alignment is mandatory;
- Alignment package is already provided;
- Crystal is very close to the antenna;
- Possibile use of different dipoles length, depending on the required band of detection;
- It is possibile to change dipoles orientation.

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System control

Delay line moved by a 6.35 μm resolution stepper motor;

Developing of a graphic software interface with MATLAB GUI for the motor:

- Motion control;
- Acquisitions and

real time visualization of the data from scope.

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Experiments

- 8 different setup changing;
- 2 measurements taken with each setup;
- 0.7ps delay line step, 3 acquisition per step;
- Low SNR expected;
- **Repetition of a peak is used to confirm** the true signal;
- We expect a peak with a length of 1ps to 1.5ps (around 2 step of the delay line).

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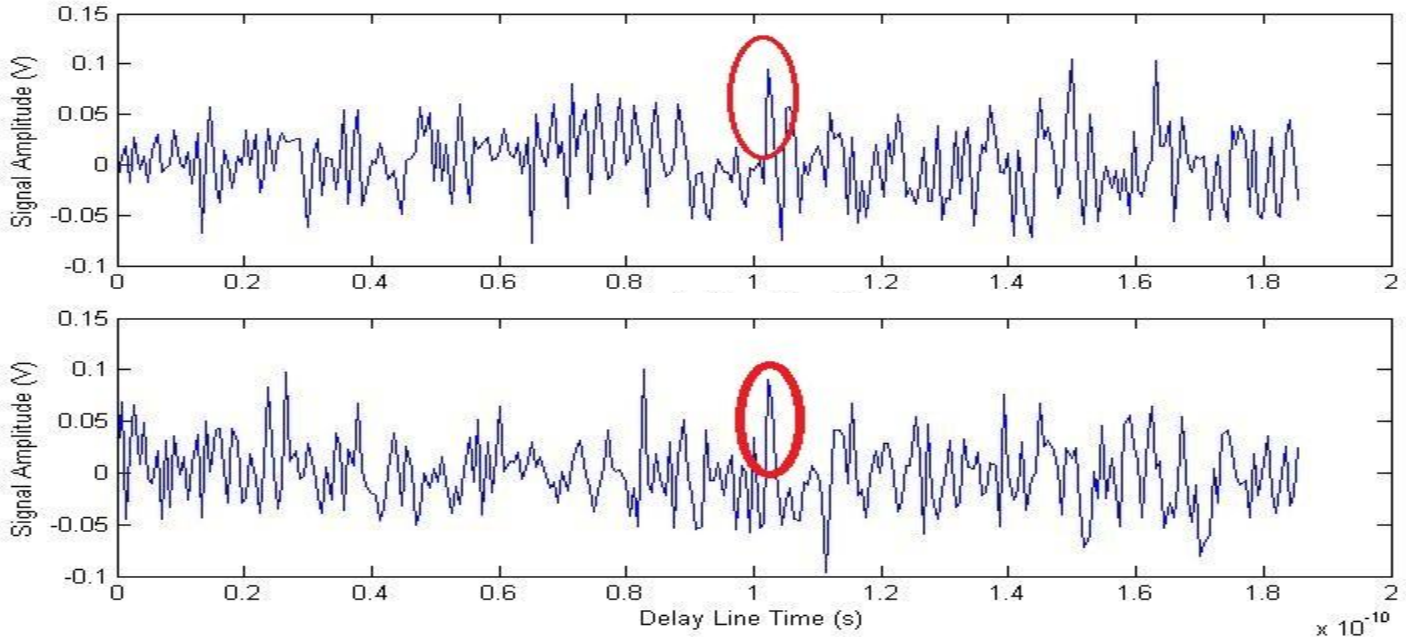
Results



- In only one case there was a repetition of a peak, consistent with the expectation;
- The probability that this event happens totally due to white noise is 1/2000;
- SNR=2.8 Compatible with the hypothesis.

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Further measurements

- Using an amplified laser beam to cross-check;
- Time resolution of the peak, using a more fine step size (up to 0.05ps) of the delay line;
- Use the system for the characterization of dielectric waveguides.

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Conclusions

- This technique provide a very high sensitivity between 1 to 4 THz;
- In a real accelerator the use of PC Antennas with coupled fiber laser can help in building a very compact and reliable setup;
- For the dielectric waveguides characterization is advisible to use (a) another antenna as a source or (b) use an amplified laser beam with a crystal;
- Limitations of this technique are (a) the bandwidth and (b) the maximum THz power permitted.

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Acknowledgments

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